PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicants: Ming-Lai Lai	)
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Serial No.: 10/777,840	)
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Filed: February 12, 2004	)
	)
For: **USE OF FINITE ELEMENT ANALYSIS FOR ORTHODONTIC MECHANICS AND APPLIANCE SELECTION**	)
	)
Group Art Unit: 3732	)
	)
Attorney Docket: 56510US004	)
	)
Examiner: J. Wilson	)
	)
Confirmation No.: 5900	)

CORRECTED APPELLANT'S BRIEF

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Pursuant to the provisions of 37 CFR §41.37, and to the Notification of Non-Compliant Appeal Brief mailed on August 3, 2007, Appellants submit this Corrected Appeal Brief. This Corrected Appeal Brief differs from the originally filed Appeal Brief only in that the section relating to the summary of the claimed subject matter has been supplemented to refer to the

independent claims by claim number. The mapping between claims and the specification as set out below is not intended to be limiting but is provided only as examples.

1. Real Party in Interest

The real party in interest is 3M of St. Paul, MN.

2. Related Appeals and Interferences

There are no other appeals or interferences known to Appellants, Appellants' legal representatives or assignees which will directly affect or be affected by or have a bearing on the Board's decision in the pending appeal.

3. Status of Claims

Claims 50-106 remain in the application. Claims 50-106 are finally rejected and are appealed. Claims 1-49 are canceled.

4. Status of Amendments

All amendments have been entered.

5. Summary of Claimed Subject Matter

As to independent claims 50, 60, 70, 89, and 103, and as disclosed on page 11, line 21 through page 15, line 15 of the present application, appropriate patient information, such as tooth size, upper and lower dental arch sizes, malocclusion type, age, gender, etc., is entered at 102 and stored for later use.

A choice between methodologies for entry of a pre-treatment model of the patient's teeth and/or dental

arches is offered at 104. A scale model may be entered at 106 and stored, and the positions of the patient's teeth may be entered or calculated and stored at 108. Additionally or alternatively, the patient's teeth or a mold of the patient's teeth may be scanned and the resulting scanned data set may be stored at 110.

The upper and lower dental arches, their relative positions, and the positions of the patient's teeth are displayed at 112, and may be used to select a proposed orthodontic treatment at 114. The proposed orthodontic treatment is entered and stored at 114. However, the initial prescription and appliance selections may instead be made automatically at 114 by comparing the pretreatment model entered at the blocks 106, 108, and/or 110 to treatment data stored in the memory system 16.

The desired final positions of the patient's teeth, based on the prescription, the patient's arch shapes, archwire shapes, tooth size, etc., are entered and stored at 116.

Intermediate positions of the patient's teeth may also be entered and stored at the block 116. One or more such intermediate positions of the patient's teeth are optionally employed where the proposed treatment strategy includes the re-positioning of the patient's teeth in stages, where each stage may involve the replacement or modification of selected appliances such as force modules and/or archwires, where each stage involves the employment of different force levels, where the orthodontist intends to use appliances whose geometries or properties change over time and may need to be replaced during treatment, and/or the like.

At 118, the initially selected appliances are applied to the patient's teeth when the teeth are at their desired final positions for full expression of the teeth, and the initially selected appliances applied to the patient's teeth when the teeth are at their desired final positions are displayed.

Accordingly, both the pre-treatment model and the post-treatment model for the patient are stored.

At 120, position vectors for each of the patient's teeth are calculated and stored. Each position vector points from the original position in the pre-treatment model to the final position in the post-treatment model for the corresponding tooth.

Further as to independent claims 50, 60, 70, 89, and 103, and as disclosed on page 15, line 16 through page 18, line 2 of the present application, the format of the resulting data file are converted at 122 for use by a finite element analysis. Optionally, the tooth and appliance geometry also is simplified at 122 so as to reduce the amount of computing power required for downstream processing.

At 124, material properties are assigned for the appliances selected at 114. The appliance material properties may be stored and may be automatically accessed upon the appliances being selected at 114, or the appliance material properties may be manually entered at 124. The appliance material properties may change as the appliances change during treatment.

Also, at 124, material properties are assigned for the patient's teeth, are stored, and are automatically accessed based on tooth type entered at

114, or the teeth material properties may be manually entered at 124.

Further, at 124, all components (teeth and appliances) are meshed. Meshing is typically done by finite element analysis programs prior to the launching of the analysis itself. A typical mesh may be used at 124, or one of the automatic mesh generators known in the art may be used.

As to independent claims 60 and 103, and as disclosed on page 18, lines 3-23 of the present application, contact pairs are defined at 124. A contact pair includes the surfaces of two appliances that contact each other. For example, the archwire and each bracket form corresponding contact pairs, the archwire and each of the ligatures that holds the archwire to a corresponding bracket form other corresponding contact pairs, and the brackets and ligatures form still other corresponding contact pairs. All such contact pairs are defined at 124 by identifying and quantifying the areas of the contact surfaces of the contact pairs. By convention, one of the appliances of a contact pair forms a contact surface and the other of the appliances of the contact pair forms a target surface.

As to independent claims 50, 60, 70, 89, and 103, and as disclosed on page 19, line 1 through page 21, line 8 of the present application, the finite element analysis is launched at 126 by moving the teeth along the position vectors from their desired final positions in the post-treatment model to their original positions in the pre-treatment model. This run of the finite element analysis determines how the archwires will deform as the teeth move along the position vectors.

At 128, data related to the patient's PDL and bone are added to the data relating to the patient's teeth. Also, PDL and bone material properties are entered at 128 and are meshed. The finite element analysis is re-run at this point in order to determine the stresses, strains, forces, friction, and moments that will be exerted on the appliances, teeth, the PDL for each tooth, and the bone by the deforming of the archwires as determined at 126.

If intermediate positions are included in the proposed orthodontic treatment, it may be necessary at 128 to finish execution of the finite element analysis at each intermediate position between the final and original positions. In the case where intermediate positions are used during treatment, the properties of the appliances must be changed when the appliances are changed at the intermediate positions. These new properties are entered at 130. Also, a bone-remodeling model and bio-mechanic material properties for PDL and bone are entered at 130 to take into account changes in PDL and bone during treatment.

At 132, the teeth and appliances are displayed along with the stresses, strains, forces, friction, and moments determined by the finite element analysis.

As to independent claims 50, 60, 70, 89, and 103, and as disclosed on page 21, line 8 through page 22, line 7 of the present application, the display at 132 is examined at 134. If, as determined at 136, the treatment strategy requires modification because the stresses, strains, forces, friction, and/or moments displayed at 132 are excessive or are outside desired ranges or because the force levels become ineffective, the

treatment strategy is changed and the processing at 114-136 is repeated using the modified treatment strategy.

If only two positions (original and final) are required for a successful treatment as determined at 138, processing may be terminated. However, if there are other positions in the treatment strategy that have not yet been processed, another iteration of the process is initiated at 140 in order to move the teeth to the next position, and flow proceeds to 108 to implement the next iteration.

6. Grounds of Rejection to be Reviewed on Appeal

(a) Claims 50-53, 58, and 59 are rejected under 35 U.S.C. §103(a) as being unpatentable over U.S. Patent No. 6,471,511 (hereinafter, "the Chishti '511 patent") in view of U.S. Patent No. 5,975,893 (hereinafter, "the Chishti '893 patent").

(b) Claims 54-57 are rejected under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent in view of the Chishti '893 patent and further in view of U.S. Patent Application Publication No. 2001/0002310 (hereinafter, "the Chishti published application").

(c) Claims 60, 61, 66-69, and 103-106 are rejected under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent.

(d) Claims 62-65 are rejected under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent in view of the Chishti published application.

(e) Claims 70-102 are rejected under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent in view of the Chishti published application.

7. Argument

Rejection Ground (a)

The Examiner rejected claims 50-53, 58, and 59 under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent in view of the Chishti '893 patent.

According to independent claim 50, the original positions of a patient's teeth are stored in memory, the desired final positions of the patient's teeth are stored in the memory, a finite element analysis is performed based on the orthodontic treatment and a movement of the patient's teeth between only the stored original and final positions, and a computer generated output that is based on the finite element analysis is provided.

Independent claim 50 is patentable over the Chishti '511 patent in view of the Chishti '893 patent for at least two reasons.

First, as the Examiner has recognized, the Chishti '511 patent does not disclose or suggest performing a finite element analysis based on a movement of the patient's teeth between only stored original and final positions. Instead, the Chishti '511 patent specifically discloses performing a finite element analysis based on the shape and material of each of a sequence of appliances to be applied to a patient.

The Chishti '893 patent does not disclose performing a finite element analysis at all. The Chishti '893 patent does disclose positioning a patient's teeth using a plurality of intermediate positions between original and final positions of a patient's teeth. The Chishti '893 patent also discloses at column 5, lines 1-7 that, in those cases where a patients' teeth are

responding very quickly, one or more intermediate appliances may be skipped so that the number of appliances is reduced below the number determined at the outset.

However, the Chishti '893 patent does not disclose or suggest that a finite element analysis be rerun using the fewer intermediate appliances. Instead, the Chishti '893 patent merely discloses that, if the treatment is progressing better than expected, one or more intermediate appliances be eliminated. At that point, however, the finite element analysis of the Chishti '511 patent would have already been performed using all of the intermediate appliances that were initially contemplated.

Therefore, because neither the Chishti '511 patent nor the Chishti '893 patent discloses or suggests performing a finite element analysis based on a movement of the patient's teeth between only stored original and final positions, neither the Chishti '511 patent nor the Chishti '893 patent would have disclosed or suggested the invention of independent claim 50 to one of ordinary skill in the art. Accordingly, for this first reason, independent claim 50 is patentable over the Chishti '511 patent in view of the Chishti '893 patent.

Second, neither the Chishti '511 patent nor the Chishti '893 patent discloses or suggests the elimination of all intermediate appliances. Indeed, the Chishti '893 patent specifically teaches that at least one intermediate appliance in addition to an initial appliance and a final appliance must be used. (See the Chishti '893 patent, column 3, lines 31-45; the system

will include at least a first appliance, an intermediate appliance, and a final appliance).

Therefore, the Chishti '893 patent does not suggest eliminating all intermediate appliances and cannot, as a result, suggest performing the finite element analysis disclosed in the Chishti '511 patent based on a movement of the patient's teeth between only original and final positions.

Accordingly, because neither the Chishti '511 patent nor the Chishti '893 patent discloses or suggests eliminating all intermediate appliances, neither the Chishti '511 patent nor the Chishti '893 patent would have disclosed or suggested the invention of independent claim 50 to one of ordinary skill in the art. Consequently, for this second reason, independent claim 50 is patentable over the Chishti '511 patent in view of the Chishti '893 patent.

On page 6 of the Final Office Action, the Examiner argues that, although the Chishti '893 patent does not teach eliminating all intermediate appliances, the Chishti '893 patent does teach eliminating at least some intermediate appliances, which would have suggested to one of ordinary skill that all intermediate appliances could be eliminated if the patient's teeth were moving sufficiently better than expected.

However, this argument is directly contrary to the express teachings of the Chishti '893 patent (see the Summary of the Invention section) which, as pointed out above, teaches the use of at least one intermediate appliance in the treatment of a patient's teeth. In other words, the Chishti '893 patent teaches one of ordinary skill in the art that, in the orthodontic

treatment methodology disclosed in the Chishti '511 patent, not all intermediate positions should be eliminated. Therefore, the Chishti '893 patent teaches one of ordinary skill in the art that the finite element analysis disclosed in the Chishti '511 patent cannot be run based on a movement of the patient's teeth between only original and final positions.

Moreover, the Examiner's argument on page 6 of the Final Office Action ignores the teaching of the Chishti '511 patent that the finite element analysis has already been performed before any appliances have actually been used on the patient. If the finite element analysis has already been performed before any appliances have actually been used on the patient, this run of the finite element analysis must have been based on intermediate appliances since it is not known at the time of running of the finite element analysis that intermediate appliances can be eliminated.

Further, since there is no suggestion to one of ordinary skill in the art of rerunning the finite element analysis if no intermediate appliance is used because the patient's teeth are moving better than expected, there can be no suggestion to one of ordinary skill in the art of running the finite element analysis between only original and final positions.

The Examiner in the first Office Action asserted that appellant in the present application himself teaches the use of intermediate steps and that appellant, therefore, does not attach any criticality to the elimination of intermediate steps. According to the Examiner, this alleged lack of criticality demonstrates that it would have been obvious to eliminate all

intermediate appliances when running the finite analysis according to the Chishti '511 patent.

Appellant responded by pointing out that it does not follow that a teaching of the use of intermediate appliances *per force* teaches that there is no criticality to the elimination of intermediate appliances. Moreover, appellant pointed out that the Examiner's assertions in this regard are immaterial to the issue of whether the combination of the Chishti '511 patent and the Chishti '893 patent would have suggested the invention of independent claim 50 to one of ordinary skill in the art. Indeed, as shown above, the combination of the Chishti '511 patent and the Chishti '893 patent would not have suggested the invention of independent claim 50 to one of ordinary skill in the art because the Chishti '893 patent teaches that not all intermediate appliances similar to those disclosed ion the Chishti '511 patent can be eliminated during an orthodontic treatment.

On page 6 of the Final Office Action, the Examiner repeated the argument that non-criticality is germane to obviousness because, according to the Examiner, if the number of positions is not critical, then eliminating all intermediary steps would have been obvious to one of ordinary skill in the art. Applicant is having difficulty following this logic. It does not logically follow that, because some intermediate appliances can be eliminated, all intermediate appliances can be eliminated. Indeed, as pointed out above, the Chishti '893 patent teaches that, although some intermediate appliances can be eliminated, all intermediate appliances should not be eliminated.

Also, this criticality argument of the Examiner relies on teaching from the present application, thus demonstrating that the Examiner is using hindsight in the rejection of these claims.

On page 6 of the Final Office Action, the Examiner argues that the disclosure in the Chishti '893 patent concerning using at least one intermediate appliance does not teach that the finite element analysis would not work if no intermediate appliance were used. However, in making this argument, the Examiner in effect is using a negative to prove a positive, i.e., if the Chishti '893 patent does not teach that the finite element analysis would not work if no intermediate appliance were used, then the Chishti '893 patent teaches that the finite element analysis would work if no intermediate appliance were used. Such an argument is not logical.

Moreover, this argument is not persuasive. The fact is that the Chishti '893 patent teaches that at least one intermediate appliance must be used, which is more suggestive of executing the finite element using at least one intermediate appliance than with no intermediate appliance.

Further, according to the Chishti '893 patent, it is not known at the time that the finite element analysis is run that intermediate appliances can be eliminated because intermediate appliances are not eliminated until it is apparent that the treatment is working better than anticipated. Therefore, the finite element analysis is executed with intermediate appliances.

Finally, with respect to independent claim 50, the Examiner asserts that the patent teaches executing the finite element analysis from one appliance to the next so that one of ordinary skill in the art would realize that the finite element analysis could be run between initial and final appliances. However, if one intermediate appliance must be used as taught in the Chishti '893 patent, then one of ordinary skill in the art would understand that the finite element analysis must be executed using at least one intermediate appliance so that the finite element analysis would not be executed between only initial and final appliances. Moreover, neither of the applied Chishti patents teaches re-executing the finite element analysis if any appliances are eliminated. Therefore, the finite element analysis is run with all anticipated intermediary appliances, contrary to the invention of independent claim 50.

For the reasons given above, the combination of the Chishti '511 patent and the Chishti '893 patent would not have suggested the invention of independent claim 50 to one of ordinary skill in the art. Accordingly, independent claim 50 is patentable over the Chishti '511 patent in view of the Chishti '893 patent.

Because independent claim 50 is patentable over the Chishti '511 patent in view of the Chishti '893 patent, dependent claims 51-53, 58, and 59 are likewise patentable over the Chishti '511 patent in view of the Chishti '893 patent.

Moreover, dependent claims 51 and 53 recite that the finite element analysis is performed based on a movement of the patient's teeth from the final positions

to the original positions. The Examiner states a mere conclusion in asserting that this claim is a matter of mere design choice. The Chishti '511 patent discloses executing the finite element analysis from the initial positions through intermediate positions to the final positions. There is not even a hint in the Chishti '511 patent or elsewhere of running the finite element analysis in the other direction. Further, the Examiner has offered no motivation for doing so. Thus, the Examiner has not established a *prima facie* case of obviousness with respect to these claims.

Moreover, the main problem of Chishti's approach of performing the analysis forwards and not backwards is that, by omitting the backwards run, the loading and displacement vectors exerted by the appliance is missing or not properly obtained. These loading and displacement vectors are important information for the treatment planning, especially if any subsequent run of finite element analysis is forwards, because they determine where and how fast the teeth are going to move. Thus, a backwards run and a forwards run have different goals and results so that comparing them would be like comparing an apple to an orange. The Chishti '511 patent and the Chishti '893 patent do not disclose either this difference in information or any other features that would suggest to the ordinary artisan that the direction of execution of the finite element analysis would be important. Because the ordinary artisan would not even think about the direction of executing the finite element analysis, the natural inclination of the ordinary artisan would be to execute the finite element forwards.

Therefore, dependent claims 51 and 53 are not suggested to those of ordinary skill art.

For these additional reasons, dependent claims 51 and 53 are patentable over the Chishti '511 patent in view of the Chishti '893 patent.

Rejection Ground (b)

The Examiner rejected claims 54-57 under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent in view of the Chishti '893 patent and further in view of the Chishti published application.

As pointed out above, the combination of the Chishti '511 patent and the Chishti '893 patent would not have suggested the invention of independent claim 50 to one of ordinary skill in the art.

The Chishti published application reinforces the disclosure in the Chishti '511 patent and the Chishti '893 patent regarding the use of intermediate positions, and does not suggest performing a finite element analysis based on a movement of the patient's teeth between only original and final positions. Therefore, adding the Chishti published application to the combination of the Chishti '511 patent and the Chishti '893 patent does not disclose or suggest the invention of independent claim 50 to one of ordinary skill in the art.

Accordingly, because the combination of the Chishti '511 patent, the Chishti '893 patent , and the Chishti published application would not have suggested the invention of independent claim 50 to one of ordinary skill in the art, independent claim 50 is patentable over the Chishti '511 patent in view of the Chishti '893

patent and further in view of the Chishti published application.

Because independent claim 50 is patentable over the Chishti '511 patent in view of the Chishti '893 patent and further in view of the Chishti published application, dependent claims 54-57 likewise are patentable over the Chishti '511 patent in view of the Chishti '893 patent and further in view of the Chishti published application.

Moreover, dependent claim 54 recites that position vectors are determined for each of the patient's teeth between the original and final positions, and that the finite element analysis is performed based on the orthodontic treatment and a movement of the patient's teeth along the position vectors.

While the Chishti published application mentions both vectors and a finite element analysis, the Chishti published application does not disclose or suggest to one of ordinary skill in the art that the vectors are used during the finite element analysis. Instead, paragraph 0179 of the Chishti published application states that the finite element analysis is executed in order to determine forces on a patient's teeth, whereas paragraph 0163 discloses that the vectors are used to determine collisions between teeth. The Chishti published application simply does not disclose or suggest also using the vectors during the finite element analysis.

According, for this reason also, dependent claim 54 is patentable over the Chishti '511 patent in view of the Chishti '893 patent and further in view of the Chishti published application.

Dependent claims 55 and 57 recite that the finite element analysis is performed based on a movement of the patient's teeth from the final positions to the original positions. For the reasons give above with respect to dependent claims 51 and 53, dependent claims 55 and 57 are patentable over the Chishti '511 patent in view of the Chishti '893 patent and further in view of the Chishti published application.

Rejection Ground (c)

The Examiner rejected claims 60, 61, 66-69, and 103-106 under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent.

As recited in independent claim 60, a finite element analysis is performed based on contact pairs between orthodontic appliances.

The Examiner recognizes that there is no disclosure in the Chishti '511 patent of performing a finite element analysis based on contact pairs between orthodontic appliances. Indeed, the Chishti '511 patent does not disclose such contact pairs at all.

However, the Examiner argues that it is well known that forces are applied through contact points and that, therefore, any teaching of evaluating forces inherently suggests considering the areas where the forces are to be transferred. The Examiner then concludes that, because of this inherency, the invention of independent claim 60 would have been obvious.

Applicant disagrees. Even if the Examiner were correct about contact points, there is no suggestion that the finite element analysis be executed based on a contact pair for each contact point. Instead, the finite

element analysis might be executed based on a contact point on each tooth. Therefore, the Examiner's argument does not necessarily lead to contact pairs.

Because the Examiner's argument does not necessarily lead to contact pairs, independent claim 60 is patentable over the Chishti '511 patent.

Moreover, the Chishti '511 patent does not teach or suggest to one of ordinary skill in the art that the use of contact pairs is an inevitable consequence of performing a finite element analysis. The Chishti '511 patent merely states that shape and material of each appliance and the patient's teeth and related mouth tissue are used in performing the finite element analysis. The Chishti '511 patent does not disclose how the finite element analysis is to be performed. Therefore, the use of contact pairs is not inherently disclosed or suggested by the Chishti '511 patent.

Because the Chishti '511 patent would not have inherently or otherwise suggested performing a finite element analysis based on contact pairs, independent claim 60 is patentable over the Chishti '511 patent.

Furthermore, even if the use of contact pairs were inherently disclosed or suggested by the Chishti '511 patent, the forces mentioned in the Chishti '511 patent are between appliance and tooth, not between appliances. Indeed, the Chishti '511 patent simply does not address forces between appliances and, therefore, cannot suggest performing a finite element analysis based on contact pairs between appliances.

Because the Chishti '511 patent would not have inherently or otherwise suggested performing a finite element analysis based on contact pairs between

appliances, independent claim 60 is patentable over the Chishti '511 patent.

Independent claim 103 recites that a finite element analysis is performed based on contact pairs between orthodontic appliances and teeth to be applied during the orthodontic treatment.

The Examiner recognizes that there is no disclosure in the Chishti '511 patent of performing a finite element analysis based on contact pairs between orthodontic appliances and teeth to be applied during the orthodontic treatment. Indeed, the Chishti '511 patent does not disclose contact pairs at all.

However, the Examiner argues that it is well known that forces are applied through contact points and that, therefore, any teaching of evaluating forces inherently suggests considering the areas where the forces are to be transferred. The Examiner then concludes that, because of this inherency, the invention of independent claim 103 would have been obvious.

The Examiner's argument is not persuasive because, to be inherent, the use of contact pairs in a finite element analysis must be an inevitable consequence of using the finite element analysis. In other words, the finite element analysis could not be run without the use of contact pairs. However, the finite element analysis could be run assuming only contact point in each tooth and not between contact pairs involving both the appliance and the tooth.

Therefore, a premise of the Examiner's argument is not true making the Examiner's argument itself not true.

Because the Examiner's argument itself is not true, the Examiner has not established a prima facie case of obviousness of independent claim 103 over the Chishti '511 patent. Therefore, independent claim 103 is patentable over the Chishti '511 patent.

Moreover, there is nothing in the Chishti '511 patent that would suggest using the specific contact pairs between appliances and teeth instead of non-specific forces applied between appliances and teeth.

Because the Chishti '511 patent does not suggest using the specific contact pairs between appliances and teeth instead of non-specific forces applied between appliances and teeth, independent claim 103 is patentable over the Chishti '511 patent.

On pages 6 and 7 of the Final Office Action, the Examiner observes that the Chishti '511 patent states that its method of (i) providing a finite element model of the appliances to be applied to a patient, (ii) providing a finite element model of the patient's teeth and related mouth tissue, (iii) computing the effect of the appliances on the patient's teeth by analyzing the finite elements models computationally, and (iv) evaluating the effect against clinical constraints can be applied to braces, including brackets and archwires. The Examiner then argues that this method would fail if it did not make the computations based on forces between the archwires and the bracket slots would fail and that, therefore, it would have been obvious to include such forces in the finite element analysis.

However, the Chishti '511 patent just does not provide any specifics as to how the finite element analysis should be executed. As far as the Chishti '511

patent is concerned, the finite element analysis might simply be executed without ever defining contact pairs. Instead, the Chishti '511 patent might simply assume non-specific forces on the patients tooth without defining the contact pair between appliances or between each appliance and each tooth. Moreover, the fact that the Chishti '511 patent does not provide the details of contact pairs and does not even mention contact pairs suggests executing the finite element analysis by assuming non-specific forces between appliances or between appliance and tooth instead of defining specific contact pairs between appliances or between appliances and teeth.

In addition, with respect to independent claim 60, the Chishti '511 patent, except for it mention that its method can be applied to braces, including brackets and archwires, is entirely focused on polymeric shells. Since a shell is a single appliance, there would be a contact pair between appliances. Therefore, the Chishti '511 patent would not have suggested to one of ordinary skill in the art the use of contact pairs between appliances.

Accordingly, the Examiner's argument about contact pairs is unsupported and unsupportable.

Because independent claims 60 and 103 are patentable over the Chishti '511 patent, dependent claims 61, 66-69, and 104-106 are likewise patentable over the Chishti '511 patent.

In addition, dependent claims 61 and 67 recite that the finite element analysis is performed based on a movement of the patient's teeth from the second or final positions to first or intermediate positions. For the

reasons given above with respect to dependent claims 51 and 53, dependent claims 61 and 67 are patentable over the Chishti '511 patent.

Dependent claim 105 recites that position vectors are determined for each of the patient's teeth between first and second positions, and that the finite element analysis is performed based on the orthodontic treatment and a movement of the patient's teeth along the position vectors. For the reasons given above with respect to dependent claim 54, dependent claim 105 is patentable over the Chishti '511 patent.

Rejection Ground (d)

The Examiner rejected claims 62-65 under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent in view of the Chishti published application.

As pointed above, the Chishti '511 patent would not have suggested to one of ordinary skill in the art the use in a finite element analysis based on the contact pairs recited in independent claim 60. Moreover, the Chishti published application also does not disclose or suggest this use of contact pairs. Therefore, adding the Chishti published application to the Chishti '511 patent would not have suggested the invention of independent claim 60 to one of ordinary skill in the art.

Accordingly, independent claim 60 is patentable over the Chishti '511 patent in view of the Chishti published application.

Because independent claim 60 is patentable over the Chishti '511 patent in view of the Chishti published application, dependent claims 62-65 are likewise

patentable over the Chishti '511 patent in view of the Chishti published application.

In addition, dependent claim 62 recites that position vectors are determined for each of the patient's teeth between first and second positions, and that the finite element analysis is performed based on the orthodontic treatment and a movement of the patient's teeth along the position vectors.

As discussed above with respect to dependent claim 54, the Chishti '511 patent does not disclose or suggest to one of ordinary skill in the art the use of such position vectors during a finite element analysis. Similarly, the Chishti published application does not disclose or suggest to one of ordinary skill in the art the use of such position vectors during a finite element analysis. According, for this reason also, dependent claim 62 is patentable over the Chishti '511 patent in view of the Chishti published application.

Dependent claims 63 and 65 recite that the finite element analysis is performed based on a movement of the patient's teeth from second or final positions to first or intermediate positions. For the reasons given above with respect to dependent claims 51 and 53, dependent claims 63 and 65 are likewise patentable over the Chishti '511 patent in view of the Chishti published application.

Rejection Ground (e)

(e) Claims 70-102 are rejected under 35 U.S.C. §103(a) as being unpatentable over the Chishti '511 patent in view of the Chishti published application.

Independent claim 70 requires storing a proposed subset of orthodontic appliances from a set of pre-existing orthodontic appliances according to a proposed orthodontic treatment, performing a finite element analysis based on the proposed orthodontic treatment, storing a new subset of orthodontic appliances from the set of pre-existing orthodontic appliances if the finite element analysis indicates that the proposed orthodontic treatment produces undesired effects, and repeating the finite element analysis.

The Chishti '511 patent does not disclose storing a proposed subset of orthodontic appliances from a set of pre-existing orthodontic appliances, testing the stored proposed subset of orthodontic appliances, and storing and testing a proposed new subset of pre-existing orthodontic appliances if the prior subset produces undesired effects. Instead, the Chishti '511 patent shows in Figure 2 that, if an appliance 100 does not produce the desired result, a new appliance to be tested is calculated rather than retrieved from memory. Thus, the appliance 100 shown in the Chishti '511 patent is not pre-existing, a sub-set of pre-existing appliances in the Chishti '511 patent is not selected and tested, and a different sub-set of pre-existing appliances in the Chishti '511 patent is not selected and tested if the prior sub-set of pre-existing appliances does not produce the desired results.

Accordingly, the Examiner relies on the Chishti published application, citing paragraph 0141 in particular.

The Chishti published application shows a polymeric appliance 100 in Figure 1C that is used to

reposition a patient's teeth. The Chishti published application states that, in some cases, it may be necessary to model the appliance 100 to accommodate an attachment within a receptacle or aperture of the appliance 100.

To this end, paragraph 0141 of the Chishti published application states that conventional attachments are available in standard shapes and sizes, that these attachments can be selected from a library of virtual attachments, and that the appliance 100 must be designed to accommodate these selected attachments when the selected attachments are needed.

As can be seen, the Chishti published application likewise does not disclose or suggest selecting and testing a subset of pre-existing appliances, and selecting and testing a new pre-existing subset of appliances if the prior sub-set of pre-existing appliances does not produce the desired results.

Moreover, assuming that the Chishti '511 patent and the Chishti published application can be combined at all, the Chishti '511 patent and the Chishti published application would merely have suggested using attachments from a library of attachments in the calculation of the appliance 100, testing the appliance 100, and re-calculating a new appliance 100 if the prior appliance 100 was not suitable. The Chishti '511 patent and the Chishti published application would not have suggested testing different attachments along with different versions of the appliance 100. Thus, the Chishti '511 patent and the Chishti published application would not have suggested the invention of independent claim 70.

On page 7 of the Final Office Action, the Examiner argues that the selection of attachments from a library inherently and obviously involves selecting a subset of attachments from a library. Even if this argument were true, the Chishti published application does not suggest testing different subsets of attachments until a suitable subset is found. The Chishti published application at most only suggests choosing a set of attachments, calculating an appliance 100 that accommodates the chosen set of attachments, testing the calculated appliance 100, calculating a new appliance 100 if the prior appliance 100 was not suitable, and testing the new appliance 100.

Accordingly, a combination of the Chishti '511 patent and the Chishti published application would not have suggested the invention of independent claim 70 to one of ordinary skill in the art.

Because the Chishti '511 patent and the Chishti published application would not have suggested the invention of independent claim 70, independent claim 70 is patentable over the Chishti '511 patent in view of the Chishti published application.

Independent claim 89 recites storing a set of orthodontic appliances, applying a subset of the stored set of orthodontic appliances to the patient's teeth according to one of first and second position models, and performing a finite element analysis based on the first position model, the second position model, and the applied subset of orthodontic appliances.

The Chishti '511 patent does not disclose or suggest storing a set of appliances or testing a subset of stored appliances with a finite element analysis.

The Chishti published application discloses that attachments can be stored in a library but does not suggest testing these attachments with a finite element analysis. The Chishti published application instead only suggests designing appliances to accommodate attachments. The Chishti '511 patent would then according to the Examiner's rationale test the appliance with a finite element analysis. However, there is nothing to suggest that both the appliance with the attachment would be tested with the finite element analysis.

Because the Chishti '511 patent and the Chishti published application would not have suggested storing appliances in a memory and selecting a subset of the stored appliances for processing by a finite elements analysis, independent claim 89 of the present application is patentable over the Chishti '511 patent in view of the Chishti published application.

Because independent claims 70 and 89 are patentable over the Chishti '511 patent in view of the Chishti published application, dependent claims 71-88 and 90-102 are likewise patentable over the Chishti '511 patent in view of the Chishti published application.

In addition, dependent claims 74, 85, 87, 95, 99, and 101 recite that the finite element analysis is performed based on a movement of the patient's teeth from second or final positions to first or original or intermediate positions. For the reasons given above with respect to dependent claims 51 and 53, dependent claims 74, 85, 87, 95, 99, and 101 are patentable over the Chishti '511 patent in view of the Chishti published application.

Dependent claims 75 and 83 recite that the finite element analysis is performed in two stages, a first stage that determines wire deformation of archwires, and a second stage that determines stresses, strains, forces, and /or moments as a result of the wire deformation.

There is not so much of a hint in either the Chishti '511 patent or the Chishti published application of performing a finite element analysis in stages. Therefore, for this additional reasons, dependent claims 75 and 83 are patentable over the Chishti '511 patent in view of the Chishti published application.

Dependent claims 76 and 97 recite that position vectors are determined for each of the patient's teeth between first and second positions, and that the finite element analysis is performed based on the orthodontic treatment and a movement of the patient's teeth along the position vectors.

Neither the Chishti '511 patent nor the Chishti published application discloses or suggests to one of ordinary skill in the art the use of such position vectors during a finite element analysis. Accordingly, for this reason also, dependent claims 76 and 97 are patentable over the Chishti '511 patent in view of the Chishti published application.

8. Claims Appendix

An appendix containing the rejected claims is attached.

9. Evidence Appendix

There is no submitted evidence. Therefore, there is no corresponding appendix.

10. Related Proceeding Appendix

There are no related proceedings. Therefore, there is no corresponding appendix.

11. Conclusion

For the foregoing reasons, reversal of the Final Rejection is respectfully requested.

The Commissioner is hereby authorized to charge any additional fees that may be required, or to credit any overpayment, to account No. 50 1519.

Respectfully submitted,

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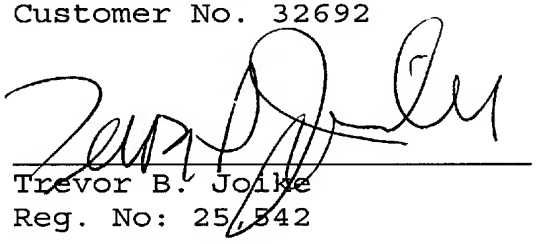
By: 

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APPENDIX

50. A computer implemented method of analyzing an orthodontic treatment comprising:

storing the original positions of a patient's teeth in memory;

storing the desired final positions of the patient's teeth in the memory;

performing a finite element analysis based on the orthodontic treatment and a movement of the patient's teeth between only the stored original and final positions; and,

providing a computer generated output that is based on the finite element analysis.

51. The computer implemented method of claim 50 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the original positions.

52. The computer implemented method of claim 50 wherein the orthodontic treatment is based upon a set of orthodontic appliances to be applied to the patient's teeth, and wherein the performing of the finite element analysis comprises performing the finite element analysis based upon the set of orthodontic appliances and the movement of the patient's teeth between the original and final positions.

53. The computer implemented method of claim 52 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the original positions.

54. The computer implemented method of claim 50 wherein the performing of the finite element analysis comprises:

determining position vectors for each of the patient's teeth between the original and final positions; and,

performing the finite element analysis based on the orthodontic treatment and a movement of the patient's teeth along the position vectors.

55. The computer implemented method of claim 54 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the original positions.

56. The computer implemented method of claim 54 wherein the orthodontic treatment is based upon a set of orthodontic appliances to be applied to the patient's teeth, and wherein the performing of the finite element analysis comprises performing the finite element analysis based upon the set of orthodontic appliances and the movement of the patient's teeth between the original and final positions.

57. The computer implemented method of claim 56 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the original positions.

58. The computer implemented method of claim 50 wherein the performing of the finite element analysis comprises:

storing material properties of the patient's teeth, PDL, and bone and of the proposed orthodontic treatment; and,

performing the finite element analysis based on the orthodontic treatment, the stored material properties, and a movement of the patient's teeth between the original and final positions.

59. The computer implemented method of claim 50 wherein the providing of a computer generated output based on the finite element analysis comprises displaying information relating to the effectiveness of the orthodontic treatment.

60. A computer implemented method of analyzing an orthodontic treatment comprising:

storing first positions of a patient's teeth in memory;

storing second positions of the patient's teeth in the memory, wherein the second positions comprise desired positions relative to the first positions;

performing a finite element analysis to determine orthodontic effects of the orthodontic treatment, wherein the finite element analysis is performed based on (i) contact pairs between orthodontic

appliances, and (ii) a movement of the patient's teeth between the first and second positions; and,

providing an output based on the orthodontic effects.

61. The computer implemented method of claim 60 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the second positions to the first positions.

62. The computer implemented method of claim 60 wherein the performing of the finite element analysis comprises:

determining position vectors for each of the patient's teeth between the first and second positions; and,

performing the finite element analysis based on the orthodontic treatment and a movement of the patient's teeth along the position vectors.

63. The computer implemented method of claim 62 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the second positions to the first positions.

64. The computer implemented method of claim 60 wherein the first positions of the patient's teeth are original positions, and wherein the second positions of the patient's teeth are final positions.

65. The computer implemented method of claim 64 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the original positions.

66. The computer implemented method of claim 60 wherein the first positions of the patient's teeth are intermediate positions, and wherein the second positions of the patient's teeth are final positions.

67. The computer implemented method of claim 66 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the intermediate positions.

68. The computer implemented method of claim 60 wherein the performing of the finite element analysis comprises:

storing material properties of the patient's teeth, PDL, and bone and of at least some of the appliances to be used during the proposed orthodontic treatment; and,

performing the finite element analysis based on the orthodontic treatment, the stored material properties, and a movement of the patient's teeth between the first and second positions.

69. The computer implemented method of claim 60 wherein the providing of an output based on the orthodontic effects comprises displaying the orthodontic effects.

70. A computer implemented method of determining an effective orthodontic treatment comprising:

a) storing in memory a first model based upon first positions of a patient's teeth;

b) storing in the memory a second model based upon second positions of the patient's teeth, wherein the second positions represent desired positions of the patient's teeth relative to the first positions of the patient's teeth;

c) storing in the memory a proposed subset of orthodontic appliances from a set of pre-existing orthodontic appliances according to a proposed orthodontic treatment;

d) performing a finite element analysis based on the proposed orthodontic treatment and a movement of the patient's teeth between the first and second positions so as to generate information regarding the effectiveness of the proposed orthodontic treatment;

e) displaying the information;

f) storing in the memory a new subset of orthodontic appliances from the set of pre-existing orthodontic appliances if the finite element analysis indicates that the proposed orthodontic treatment produces undesired effects; and,

g) repeating d) - f) as necessary until the effective orthodontic treatment is achieved.

71. The computer implemented method of claim 70 wherein the undesired effects include stresses and/or strains outside of a desired range.

72. The computer implemented method of claim 70 wherein the undesired effects include stresses and/or strains above or below an acceptable limit.

73. The computer implemented method of claim 70 wherein the performing of the finite element analysis comprises performing the finite element analysis based on the stored first and second models.

74. The computer implemented method of claim 70 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the second positions to the first positions.

75. The computer implemented method of claim 70 wherein the performing of the finite element analysis comprises performing the finite element analysis in two stages, wherein the first stage determines wire deformation of archwires, and wherein the second stage determines stresses, strains, forces, and /or moments as a result of the wire deformation.

76. The computer implemented method of claim 70 wherein the performing of the finite element analysis comprises:

determining position vectors for each of the patient's teeth between the first and second positions; and,

performing the finite element analysis based on the orthodontic treatment and a movement of the patient's teeth along the position vectors.

77. The computer implemented method of claim 70 further comprising displaying the first model.

78. The computer implemented method of claim 77 wherein storing in the memory of a proposed subset of orthodontic appliances from a set of pre-existing orthodontic appliances comprises selecting the proposed subset of orthodontic appliances based on the displayed first model.

79. The computer implemented method of claim 70 wherein the storing in the memory of a proposed subset of orthodontic appliances from a set of pre-existing orthodontic appliances comprises installing the proposed subset of orthodontic appliances on the second model.

80. The computer implemented method of claim 79 further comprising displaying the installed subset of orthodontic appliances on the second model.

81. The computer implemented method of claim 79 further comprising displaying the first model.

82. The computer implemented method of claim 81 wherein the storing in the memory of a proposed subset of orthodontic appliances from a set of pre-existing orthodontic appliances comprises selecting the proposed subset of orthodontic appliances based on the displayed first model.

83. The computer implemented method of claim 79 wherein the performing of the finite element analysis comprises performing the finite element analysis in two stages, wherein the first stage determines wire deformation of archwires, and wherein the second stage determines stresses, strains, forces, and /or moments on the proposed set of orthodontic appliances as a result of the wire deformation.

84. The computer implemented method of claim 70 wherein the first positions of the patient's teeth are original positions, and wherein the second positions of the patient's teeth are final positions.

85. The computer implemented method of claim 84 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the original positions.

86. The computer implemented method of claim 70 wherein the first positions of the patient's teeth are intermediate positions, and wherein the second positions of the patient's teeth are final positions.

87. The computer implemented method of claim 86 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the intermediate positions.

88. The computer implemented method of claim 70 wherein the performing of the finite element analysis comprises:

storing in the memory material properties of the patient's teeth, PDL, and bone and of the proposed orthodontic treatment; and,

performing the finite element analysis based on the proposed orthodontic treatment, the stored material properties, and a movement of the patient's teeth between the first and second positions.

89. A computer readable storage medium having program code stored thereon which, when executed by a computer, performs the following tasks:

a) storing a first position model of a patient's teeth, wherein the first position model represents first positions of the patient's teeth;

b) storing a second position model of the patient's teeth, wherein the second position model represents second positions of the patient's teeth, and wherein the second positions comprise desired positions relative to the first positions;

c) storing a set of orthodontic appliances;

d) applying a subset of the stored set of orthodontic appliances to the patient's teeth according to one of the first and second position models;

e) performing a finite element analysis based on the first position model, the second position model, and the applied subset of orthodontic appliances to produce finite element analysis data; and,

producing an output relative to the finite element analysis data.

90. The computer readable storage medium of claim 89 wherein the producing of an output relative to the finite element analysis data comprises displaying the finite element analysis data.

91. The computer readable storage medium of claim 90 wherein the finite element analysis data comprises stresses, strains, forces, and/or moments resulting from the applied set of orthodontic appliances.

92. The computer readable storage medium of claim 89 wherein the storing of a first position model comprises displaying upper and lower arches of the patient.

93. The computer readable storage medium of claim 89 wherein the applying of the subset of orthodontic appliances comprises displaying the applied subset of orthodontic appliances on the patient's teeth.

94. The computer readable storage medium of claim 89 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth between the first and second positions as represented by the first and second position models.

95. The computer readable storage medium of claim 89 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the second positions to the first positions as represented by the first and second position models.

96. The computer readable storage medium of claim 89 wherein the applying of the subset of orthodontic appliances comprises applying the subset of orthodontic appliances to the patient's teeth according to the second position model.

97. The computer readable storage medium of claim 89 wherein the performing of the finite element analysis comprises:

determining position vectors for each of the patient's teeth between the first and second positions as represented by the first and second position models; and,

performing the finite element analysis based on the applied set of orthodontic appliances and a movement of the patient's teeth along the position vectors.

98. The computer readable storage medium of claim 89 wherein the first position model represents original positions of the patient's teeth, and wherein the second position model represents final positions of the patient's teeth.

99. The computer readable storage medium of claim 98 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the original positions.

100. The computer readable storage medium of claim 89 wherein the first position model represents intermediate positions of the patient's teeth, and wherein the second position model represents final positions of the patient's teeth.

101. The computer readable storage medium of claim 100 wherein the performing of the finite element analysis comprises performing the finite element analysis based on a movement of the patient's teeth from the final positions to the intermediate positions.

102. The computer readable storage medium of claim 89 wherein the performing of the finite element analysis comprises:

storing material properties of the patient's teeth, PDL, and bone and of the proposed orthodontic treatment; and,

performing the finite element analysis based on the first position model, the second position model, the assigned material properties, and the applied subset of orthodontic appliances.

103. A computer implemented method of analyzing an orthodontic treatment comprising:

storing first positions of a patient's teeth in memory;

storing second positions of the patient's teeth in the memory, wherein the second positions comprise desired positions relative to the first positions;

performing a finite element analysis to determine orthodontic effects of the orthodontic treatment, wherein the finite element analysis is performed based on (i) contact pairs between orthodontic appliances and teeth to be applied during the orthodontic treatment, and (ii) a movement of the patient's teeth between the first and second positions; and,

providing an output based on the orthodontic effects.

104. The computer implemented method of claim 60 further comprising defining the contact pairs prior to performing of the finite element analysis.

105. The computer implemented method of claim 103 wherein the performing of the finite element analysis comprises:

determining position vectors for each of the patient's teeth between the first and second positions; and,

performing the finite element analysis based on the orthodontic treatment and a movement of the patient's teeth along the position vectors.

106. The computer implemented method of claim 103 wherein the performing of the finite element analysis comprises:

storing material properties of the patient's teeth, PDL, and bone and of at least some of the appliances to be used during the proposed orthodontic treatment; and,

performing the finite element analysis based on the orthodontic treatment, the stored material properties, and a movement of the patient's teeth between the first and second positions.